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ABSTRACT

The preferences of a group of 35 randomly selected undergraduate and graduate students for different text density on computer screens were examined in this study. The displays, which ranged from 53% to 22% density, were generated using the Apple IIe microcomputer. Students were shown a pair of screens of different densities and asked which screen they preferred. The data were analyzed using the paired comparison technique. Results showed that the students' first preference was the 31% density screen, with 26% second, 22% third, and 53% last. The empirical data seemed to support the idea that there is an optimum in screen density. The text is supplemented by seven tables and one figure, and 20 references are provided. (EW)

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Results of a Pilot Study of Text Density Preference Using the Paired Comparison Technique

by

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I. Review of Literature

With the increased use of computers in both business and academic environments, computer screen design has become an important area for instructional design research. This research is divided into two broad catagories: use of color and use of space.

The use of color in screen design has been extensively studied (Christ,1975; Christ & Corso,1975; Teichner, Christ, & Corso,1975; Tullis,1981). Richard Christ (1975) analyzed the results of 42 studies which discussed the effects of color coding. These studies indicate that effective usage of color depended upon the tasks required. Search tasks are enchanced by color, while identification tasks are sometimes enhanced and sometimes degraded. With the extra cost of adding color capabilities to existing hardware and research indicating that color adds no special advantage to human performance, it is reasonable to assume that industry will make no strong effort to incorporate this newest area of computer enhancement. However, purchases are not made on these type decisions. Even though we assume no particular benefits for color in improving instruction, nevertheless, color based educational software will be developed and purchased at an ever increasing rate. The value that is added by color is more for show than instructional improvement.

Text density deals with the relationship between the number of characters and blank spaces on a computer screen expressed as a percentage. There is substantial evidence to suggest that a computer screen can present too much information at one time.

It is suggested that high density levels cause perception to become overloaded (Cropper & Evans,1968). Engel and Granda (1975) have stated that increased density levels result in increased error rates. Alternately, if too little information is presented per screen, the base length of time to complete a lesson is increased due to the time involved in paging in CBI. Low density screens may provide so little information that a learner's normal reading rate is "subverted", thus decreasing the learner's comprehension of the text. Both of these studies strongly suggest that there is an optimum text density.

There have been numerous guidelines developed concerning text density. These guidelines cover a wide range from a conceptual discussion of displays (Danchak,1976; Grace,1966; Green,1976; Peterson,1979; Rosenthal,1979) to very specific lists of rules for screen display design (Bailey,1982; Galitz,1980; NASA,1980; Smith & Aucella, 1983). The conceptual approach seems to offer the most support for screen design because the rules approach never seems to be appropriate for the designer's individual problem. The result is often that screen design is based on the author's own ideas rather than documented data.

While studies by Cakir (1980), Green (1976), Peterson (1979), Golitz (1980), Tullis (1983) and others state that text density needs to be lower, the exact density level is open to wide variances. These range from a high of 60% (NASA,1980) to a low of 15% (Danchak, 1976). This lack of agreement with relation to the level of text density led to the creation of a text density study originally designed by Drs. Steven Ross and Gary Morrison of Memphis State University.

II. Instrument and Methods

The question of an acceptable level of text density has never been answered satisfactorialy. An instrument (computer program) was constructed that was divided into two sections. The first surveyed attitudes towards computers, and the second recorded screen preferences. A laboratory computer controlled the display and recorded the data, which fell into three general areas. The first was personal information that asked name, sex, and college status (graduate or undergraduate). The second part was an attitude survey that made nine statements about how the respondent felt about using computers (see figure 1).

Insert figure 1 about here

These were ranked on a scale from 1 to 5, ranging from completely false to completely true.

The third section of the survey analyzed preferences for text density. There were 6 comparison choices for the respondents to make that varied the text density at 53%, 31%, 26%, and 22%. The screen text was from an introductory unit on central tendency, patterned after the original text (Ross,1982). The respondents were shown individual screens and asked to choose between the following pairs:

Insert table 1 about here

The displays were generated using the Apple IIe computer with a monochrome monitor. The unit was self-paced and the space bar was used to advance each frame. Once the pairs of text screens were shown, the respondent was asked which one they preferred. After the initial response, the respondent was asked whether this was the correct choice they wanted to make and were given the opportunity to review either or both screen designs. This information was stored on the computer disk and was gathered periodically from a master disk.

The density levels of each screen were more the result of chunking in meaningful units rather than pre-setting these levels. Therefore, the computer frames were "designed independently, using what were subjectively decided to be the most appropriate screen layouts for presenting material" (Morrison, Ross, & O'Dell, 1988, p.106).

The subjects were 35 students from Memphis State University. There were 26 females and 9 males; 14 undergraduate and 21 graduate students all randomly selected. The entire test took no more than 20 minutes.

III. STATISTICS

The results of the attitude survey have been analyzed and their mean scores are listed below in table 2.

Insert table 2 about here

It is interesting to note that most people seem to feel comfortable with the computer (questions 2, 8, & 9) and do not seem to be intimidated by them (question 4).

The results of the comparison study are shown in the frequency matrix shown below

in table 3. This frequency matrix shows the number of times each screen was selected.

Insert table 3 about here

The data was analyzed using the paired comparison technique that ranks options that have been considered two at a time (Davis & McLean, 1988). The respondent is to select the option that is (in this case) more desirable in each pair displayed. The data from table 3 was summarized on a proportion matrix (p matrix, see table 4) that showed the number of times one option was preferred over the other. This is constructed by converting ordered pairs of numbers into fractions. Note that the diagonal contains .50, which assumes that if the option were considered against itself, either screen would be selected .50 of the time.

Insert table 4 about here

The results of this matrix were converted to *z* scores and a matrix was again constructed (*z* matrix, see table 5). "If the proportion is less than .50, then the value falls to the left of the mean on the standard normal curve...(and once subtracted from .50) the resulting *z* scores represent the degree to which the observed proportions depart from a neutral 50/50 split" (Davis & McLean, 1988, p. 990). The larger (or smaller) the *z* score, the greater the differences between observed and no preference between the paired options.

Insert table 5 about here

The resulting negative numbers were eliminated by taking the smallest scale value (-.1387) and adding it to the mean scores of each column. The resulting numbers were converted to a *z* scale, which can be treated as an interval scale to make it easier to interpret the results.

Insert table 6 about here

A bar chart is also provided to more easily display the results of the number of times each density level was selected.

Insert table 7 about here

IV. DISCUSSION

From this interval scale it can be easily determined that the 31% density screens were preferred, with 26% second, 22% third, and 53% last. These results pose an interesting model for the instructional designer to consider. While the 31% density level was the most preferred, it is interesting to note that the 53% was last. The empirical data seem to support the idea that there is indeed an optimum in screen density.

V. SUMMARY

The amount of information being disseminated each day over computer screens is growing. There have been many suggestions as to how much text should be on a screen. As the amount of information per screen goes up, error rates follow in the same direction. By optimizing the amount of information per screen, a learner's perception of the instruction is improved. This could impact on a learner's attention, motivation, time on task, and ultimately his performance level.

This pilot study has since been completed, and further studies of this same theme are currently in progress (Morrison, Ross, & O'dell,1988; Morrison, Ross, O'Dell, & Schultz, 1988). Future areas of concern should analyze error rates as text density increases, thus enabling instructional designers to determine the maximum amount of information that can be presented on a screen with the greatest retention. Another consideration for future study is whether high ability students prefer denser screens.

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Attitude Survey for the Density Study

1. I like the idea of using a computer to learn
2. I feel confident with my ability to learn about computers.
3. I wish I could use computers more in my coursework.
4. Computers make me feel dumb.
5. A job using computers would be very interesting.
6. I feel comfortable using computers.
7. Working with computers would be boring.
8. I know that if I work hard to learn about computers, I can do well.
9. I am able to do as well working with computers as most others my age.

RESPONSES

1. COMPLETELY FALSE
2. FALSE MUCH OF THE TIME
3. SOMETIMES FALSE, SOMETIMES TRUE
4. TRUE MUCH OF THE TIME
5. COMPLETELY TRUE

figure 1

Paired Screen Densities

53% to 31%	53% to 26%	53% to 22%
31% to 26%	31% to 22%	26% to 22%

table 1

Opinion Survey Responses

Items	1	2	3	4	5	6	7	8	9
Mean	3.8	4.0	3.7	1.9	3.6	3.7	2.3	4.4	4.4

values range from 1-5

table 2

Screen Preference Frequency Matrix

53% to 31%		53% to 26%		53% to 22%	
14	21	14	21	17	18
31% to 26%		**31% to 22%**		**26% to 22%**	
23	12	24	11	18	17

table 3

PMatrix

22%	.50	.514	.685	.486
26%	.485	.50	.657	.40
31%	.314	.343	.50	.40
53%	.514	.60	.60	.50

table4

ZMatrix

22%	0.00	.045	.465	-.045
26%	-.045	0.00	.415	-.25
31%	-.465	-.415	0.00	-.25
53%	.045	.255	.255	0.00
sum	-.465	-.115	1.13	-.545
mean	-.1162	-.0288	.285	-.1387
+.1387	.023	.11	.424	0.00

table 5

Interval Scale Comparison

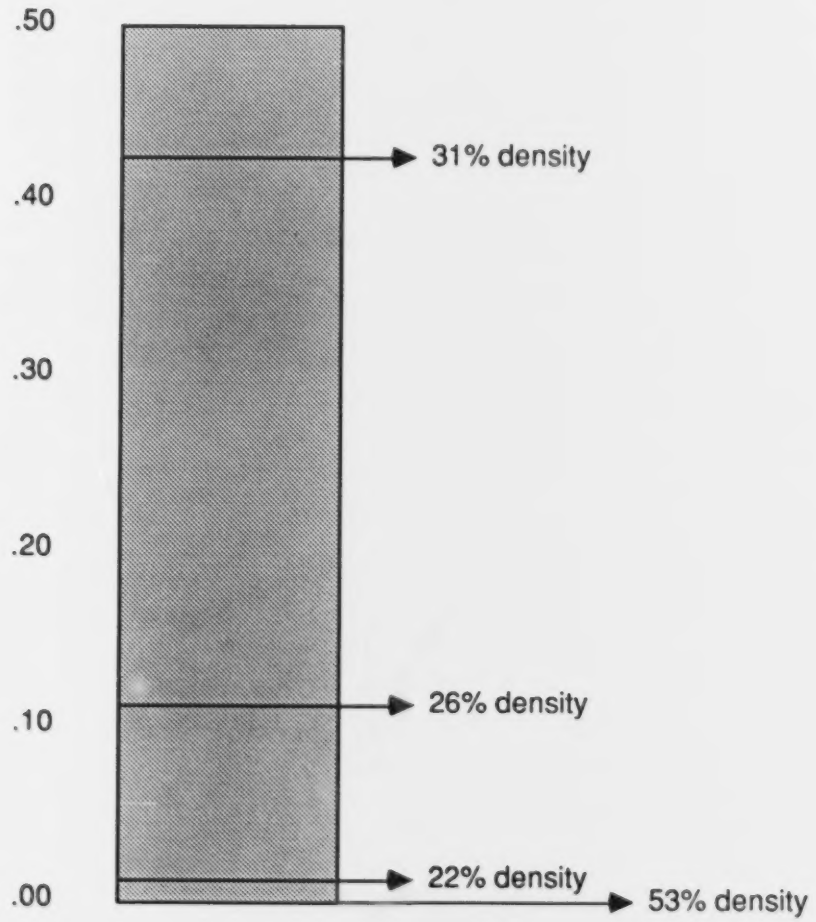

table 6

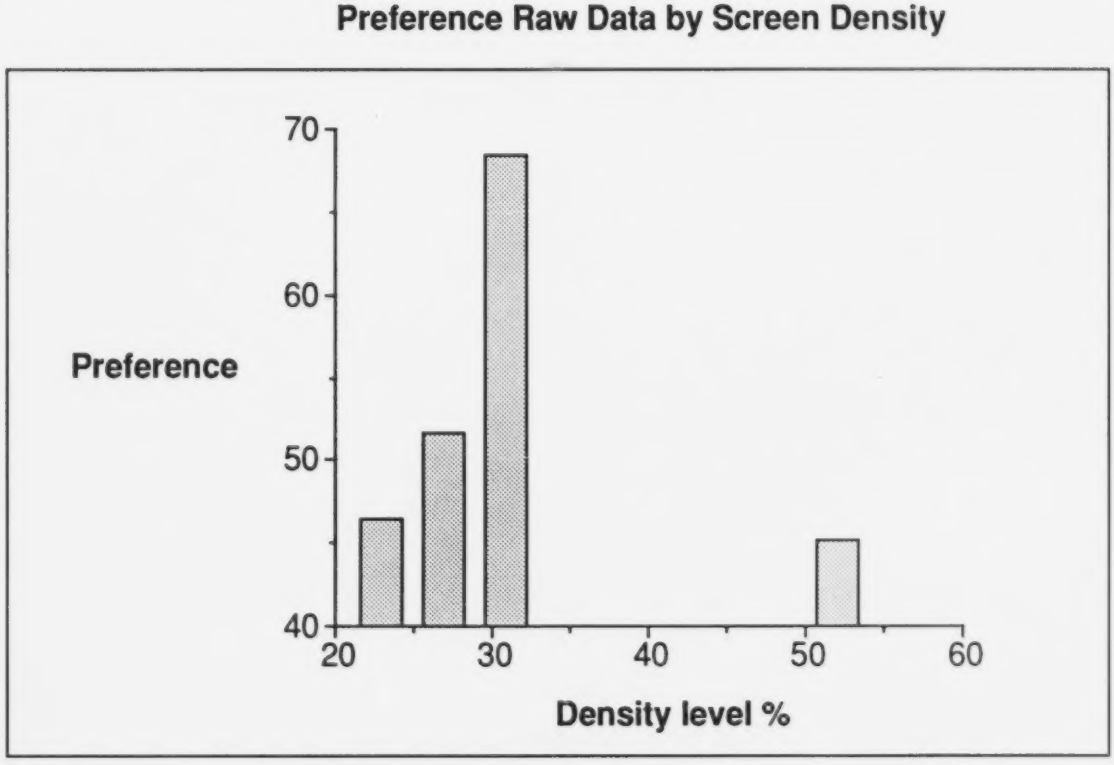
Preference Raw Data by Screen Density
Preference
70
60
50
40
20
30
40
50
60
Density level %

table7